

CLAIM AMENDMENTS

1. (Currently Amended)

A method for forming a film

comprising a first process and a second process,

the first process comprising the steps of:

(i) supplying a discharge gas containing nitrogen in an amount of 50% by volume or more based on a volume of the discharge gas, to a first discharge space of an atmospheric pressure plasma processing apparatus, the first discharge space is formed between a first electrode and a second electrode which are facing each other, where a high frequency electric field A is generated at atmospheric pressure or at approximately atmospheric pressure in the first discharge space, ~~wherein high frequency electric field A is formed~~ by superposing a first high frequency electric field of 200 kHz or less and a second high frequency electric field of 800 kHz or more, the first high frequency electric field is applied to the first electrode and the second high frequency electric field applied to the second electrode, ~~and~~ whereby the discharge gas is excited;

(ii) transferring energy of the excited discharge gas to a film forming gas, whereby the film forming gas is excited; and

(iii) exposing a substrate to the excited film forming gas, whereby a film is formed on the substrate,

the second process comprising the steps of:

(iv) supplying a gas containing an oxidizing gas to a second discharge space of the atmospheric pressure plasma processing apparatus where high frequency electric field B is generated at atmospheric pressure or at approximately atmospheric pressure, whereby the gas containing the oxidizing gas is excited; and

(v) exposing the film formed in the first process to the excited gas containing the oxidizing gas, and

moving the substrate between the first discharge space and the second discharge space.

2. (Currently Amended)

A method for forming a film

comprising a first process and a second process,

the first process comprising the steps of:

(i) supplying a discharge gas containing nitrogen in an amount of 50% by volume or more based on a volume of the discharge gas, to a first discharge space of an atmospheric pressure plasma processing apparatus, the first discharge space is formed between a first electrode and a second electrode which are facing each other, where a high frequency electric field A is generated at atmospheric pressure or at approximately atmospheric pressure, ~~wherein high frequency electric field A is~~

~~formed~~ in the first discharge space by superposing a first high frequency electric field of 200 kHz or less and a second high frequency electric field of 800 kHz or more, the first high frequency electric field is applied to the first electrode and the second high frequency electric field applied to the second electrode, and whereby the discharge gas is excited;

(ii) putting a film forming gas in contact with the excited discharge gas;

(iii) exposing a substrate to the film forming gas put in contact with the excited discharge gas, whereby a film is formed on the substrate,

the second process comprising the steps of:

(iv) supplying a gas containing an oxidizing gas to a second discharge space of the atmospheric pressure plasma processing apparatus where high frequency electric field B is generated at atmospheric pressure or at approximately atmospheric pressure, whereby the gas containing the oxidizing gas is excited; and

(v) exposing the film formed in the first process to the excited gas containing the oxidizing gas, and

moving the substrate between the first discharge space and the second discharge space.

3. (Currently Amended)

A method for forming a film
comprising a first process and a second process,
the first process comprising the steps of:

(i) supplying gas 1 containing a film forming gas and a discharge gas containing nitrogen in an amount of 50 % by volume or more based on a volume of the discharge gas, to a first discharge space of an atmospheric pressure plasma processing apparatus, the first discharge space is formed between a first electrode and a second electrode which are facing each other, where a high frequency electric field A is generated at atmospheric pressure or at approximately atmospheric pressure, ~~wherein high frequency electric field A is formed in the first~~ discharge space by superposing a first high frequency electric field of 200 kHz or less and a second high frequency electric field of 800 kHz or more, the first high frequency electric field is applied to the first electrode and the second high frequency electric field applied to the second electrode, and whereby gas 1 is excited; and

(ii) exposing a substrate to exited gas 1, whereby a film is formed on the substrate,

the second process comprising the steps of:

(iii) supplying gas 2 containing an oxidizing gas to a second discharge space of the atmospheric pressure plasma processing apparatus where high frequency electric field B is generated at atmospheric pressure or at approximately atmospheric pressure, whereby gas 2 is excited;

(iv) exposing the film formed in the first process to excited gas 2 containing the oxidization gas, and

moving the substrate between the first discharge space and the second discharge space.

4. (Currently Amended)

The method of claim 3, wherein:

~~gas 1 contains a~~ the ~~discharge gas and a reducing gas in~~
~~addition to the film forming gas; and~~
~~the discharge gas contains nitrogen of which content is 50%~~
~~by volume or more based on a volume of the discharge gas~~ further
comprising a reducing gas.

5. (Original)

The method of claim 4, wherein the reducing gas is hydrogen.

6. (Canceled)

7. (Currently Amended)

The method of claim ~~6~~ 3, wherein:

a frequency of the second high frequency electric field ω_2 is higher than a frequency of the first high frequency electric field ω_1 ;

intensity of the first high frequency electric field V_1 , intensity of the second high frequency electric field V_2 , and intensity of discharge starting electric field IV_1 satisfy one of the formulas:

$V_1 \geq IV_1 > V_2$ and $V_1 > IV_1 \geq V_2$; and

a power density of the second high frequency electric field is not less than 1 W/cm^2 .

8. (Original)

The method of claim 7, wherein:

high frequency electric field B is formed by superposing a third high frequency electric field and a fourth high frequency electric field.

9. (Original)

The method of claim 8, wherein:

a discharge space of the second process is formed between a third electrode and a fourth electrode which are facing each other; and

the third high frequency electric field is applied by the third electrode and the fourth high frequency electric field is applied by the fourth electrode.

10. (Previously Presented)

The method of claim 9, wherein the first electrode and the third electrode are common.

11. (Original)

The method of claim 8, wherein:

a frequency of the fourth high frequency electric field ω_4 is higher than a frequency of the third high frequency electric field ω_3 ;

intensity of the third high frequency electric field V_3 , intensity of the fourth high frequency electric field V_4 , and intensity of discharge starting electric field IV_2 satisfy one of the formulas:

$$V_3 \geq IV_2 > V_4 \text{ and } V_3 > IV_2 \geq V_4; \text{ and}$$

a power density of the fourth high frequency electric field is not less than $1\text{W}/\text{cm}^2$.

12. (Original)

The method of claim 3, wherein the film is a metal oxide film.

13. (Original)

The method of claim 3, wherein the film is a transparent conductive film.

14. (Original)

The method of claim 3, wherein the film forming gas contains an organo-metallic compound having a metal atom selected from the group consisting of indium(In), tin(Sn), zinc(Zn), zirconium(Zr), antimony(Sb), aluminum(Al), gallium(Ga) and germanium(Ge).

15. (Original)

The method of claim 3, wherein the first process and the second process are alternately repeated a plurality of times.

16. (Original)

The method of claim 3, wherein a thickness of the accumulated film in the first process per batch is not more than 10 nm.

17. (Currently Amended)

A method for forming a film comprising a first process and a second process,

the first process comprising the steps of:

(i) supplying gas 1 containing a film forming gas to a first discharge space of an atmospheric pressure plasma processing apparatus at atmospheric pressure or at approximately atmospheric pressure the first discharge space is formed between a first electrode and a second electrode which are facing each other;

(ii) applying high frequency electric field A to the first discharge space, whereby gas 1 is excited; and

(iii) exposing a substrate to the excited gas 1 whereby a film is formed on the substrate,

wherein

(a) the high frequency electric field A is formed by superposing a first high frequency electric field and a second high frequency electric field, the first high frequency electric

field is applied to the first electrode and the second high frequency electric field applied to the second electrode;

(b) a frequency of the second high frequency electric field ω_2 is higher than a frequency of the first high frequency electric field ω_1 ;

(c) intensity of the first high frequency electric field V_1 , intensity of the second high frequency electric field V_2 , and intensity of discharge starting electric field IV_1 satisfy one of the following formulas:

$$V_1 \geq IV_1 > V_2 \text{ and } V_1 > IV_1 \geq V_2;$$

(d) a power density of the second high frequency electric field is not less than 1 W/cm^2 ;

(e) gas 1 contains a reducing gas and a discharge gas;

(f) the discharge gas contains nitrogen of which content is 50% by volume or more based on a volume of a discharge gas in addition to the film forming gas; and

(g) the film forming gas contains an organo-titanium compound,

the second process comprising the steps of:

(iv) supplying gas 2 containing an oxidizing gas to a second discharge space of the atmospheric pressure plasma processing apparatus at atmospheric pressure or at approximately atmospheric pressure;

(v) applying high frequency electric field B to the second discharge space, whereby gas 2 is excited; and

(vi) exposing a substrate having thereon a film formed by gas 1 to excited gas 2, and

moving the substrate between the first discharge space and the second discharge space.

18. (Original)

The method of claim 17, wherein the reducing gas is hydrogen.

19. (Canceled)

20. (Currently Amended)

The method of claim ~~19~~ 17, wherein:

high frequency electric field B is formed by superposing a third high frequency electric field and a fourth high frequency electric field.

21. (Previously Presented)

The method of claim 20, wherein:

the second discharge space of the second process is formed between a third electrode and a fourth electrode which are facing each other; and

the third high frequency electric field is applied by the third electrode and the fourth high frequency electric field is applied by the fourth electrode.

22. (Previously Presented)

The method of claim 21, wherein the first electrode and the third electrode are common.

23. (Original)

The method of claim 20, wherein:

a frequency of the fourth high frequency electric field ω_4 is higher than a frequency of the third high frequency electric field represented by ω_3 ;

intensity of the third high frequency electric field V_3 ,
intensity of the fourth high frequency electric field V_4 ,

and intensity of discharge starting electric field IV_2
satisfy one of the following formulas:

$$V_3 \geq IV_2 > V_4 \text{ and } V_3 > IV_2 \geq V_4; \text{ and}$$

a power density of the fourth high frequency electric field is not less than 1 W/cm^2 .

24. (Original)

The method of claim 17, wherein the first process and the second process are alternately repeated a plurality of times.

25. (Original)

The method of claim 17, wherein a thickness of the film accumulated in the first process per time is not more than 20 nm.

26. (Original)

A substrate having thereon the film formed by the method of claim 3.